THE FUNDAMENTALS

theta

The first thing that a phonographer must understand is that the turntable platter and a record can both be mathematically represented by the circle. The circle is a geometric structure which can be broken down into 360° as shown in *figure A*

Any number of degrees is called an angle and can be expressed in terms of the Greek character theta. this letter looks like this→ **θ**

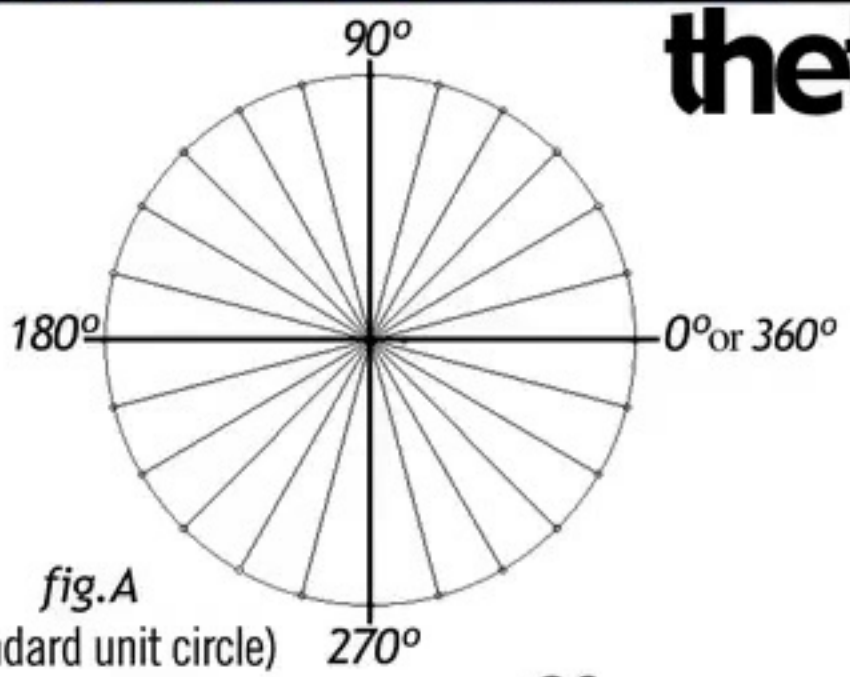
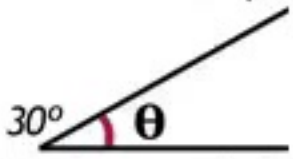


fig.A
(a standard unit circle)

to visualize theta, here is an example of an angle:



θ =30°

thus theta equals 30 degrees in this example

† so what does this have to do with scratching? what this basic geometry means to the phonographer is that any sample can be represented by an angle **θ**

for this example, let's use the most familiar phonetic sample- the *fresh* sound

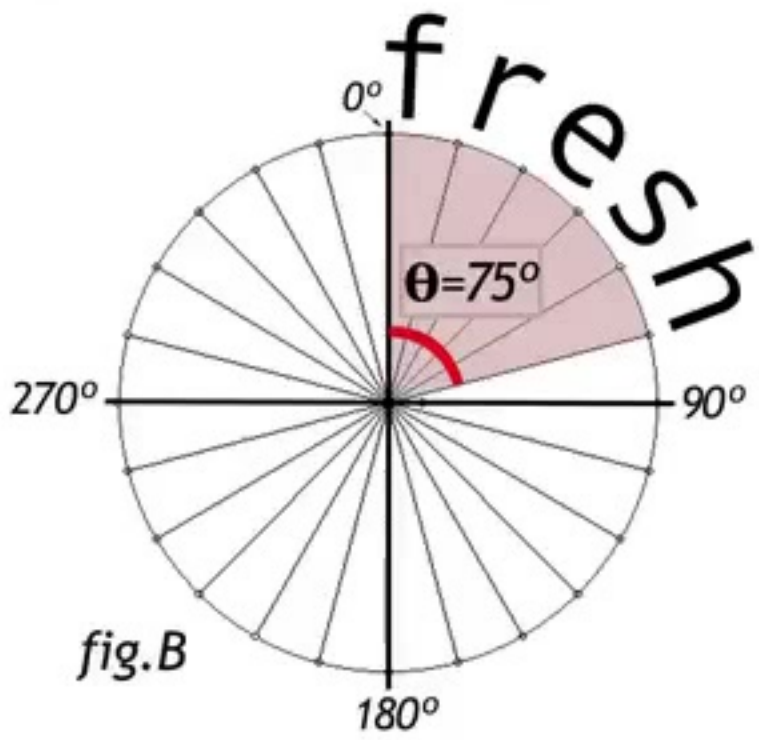


fig.B

in this example, 0° is the **starting point** and 75° is endpoint of the sample thus the the length of the sample is 75° and is called the **sample length**
it is also important to understand that the direction which the phonographer uses to measure degrees is the reverse of the standard unit circle in *fig.A* since turntables(in general) rotate clockwise, a clockwise direction of measurement provides a more accurate representation as shown here in *fig.C*

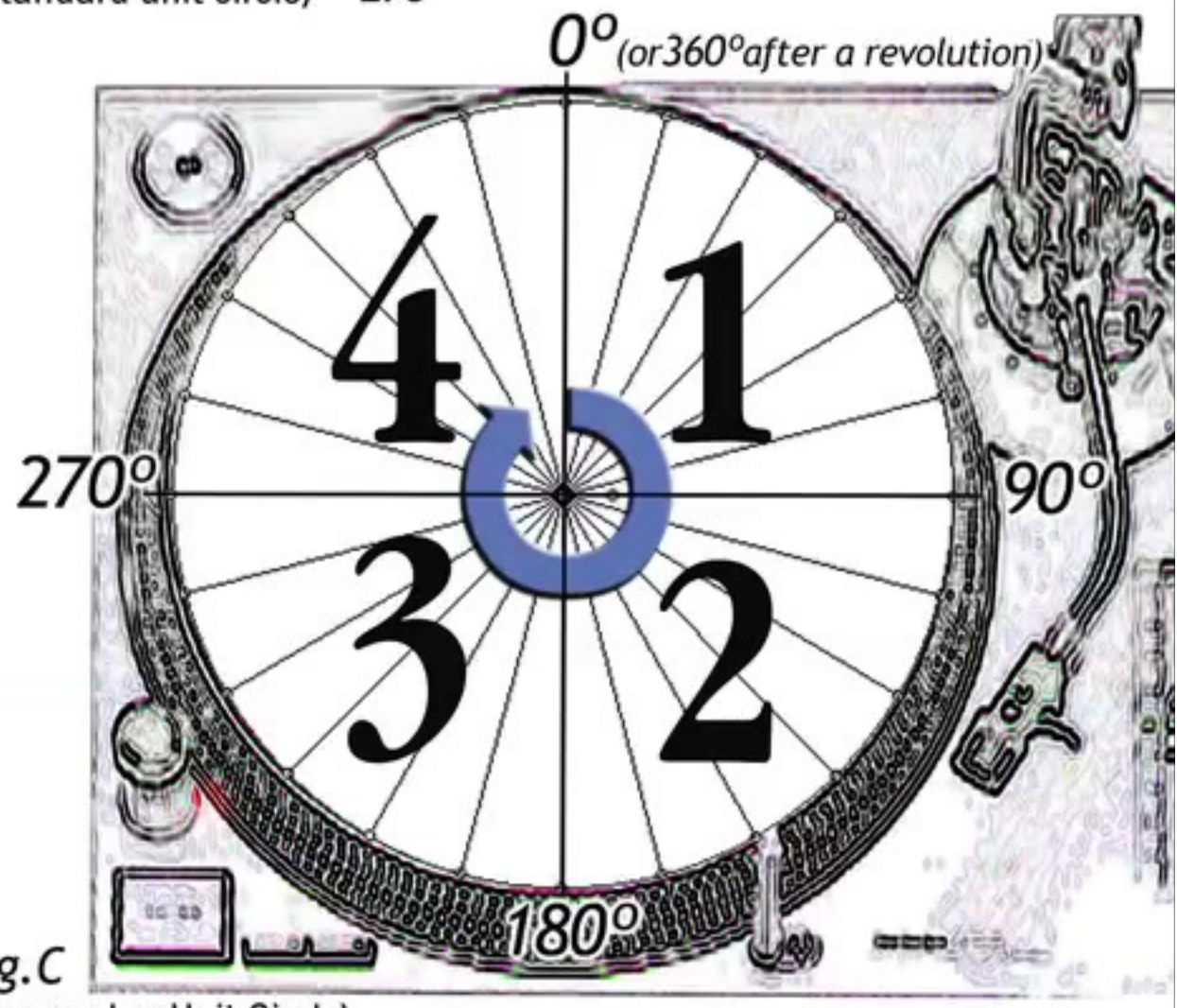


fig.C
(The Phonographer Unit Circle)

the diagram displayed above(*fig.C*) is a 360° circle which is divided into four quadrants. the order of the quadrants, beginning with #1, follow the clockwise motion of the platter. each quadrant represents a 90° angle. beginning at the **starting point**-quadrant #1 represents from 0° to 90°, quadrant #2 from 90° to 180°, quadrant #3 from 180° to 270° and quadrant #4 from 270° back to the starting point of 0°. this movement around the the platter is called a **revolution**. after each revolution around the Phonographer Unit Circle, the phonographer returns to the quadrant where they started. if the sample length of a particular sample happens to be above 90° (let's say 120°), the sample lies in both quadrants 1 and 2. if a sample length is 300°, it lies in all four quadrants. we will go into more depth about quadrants later on. for now it is important for the phonographer to understand that the platter does not necessarily have to be divided into fourths- it can be divided into thirds, fifths, sixths etc. for the sake of education, we'll stick to fourths.

theta over time

The most essential element of scratch notation is using symbols to dipict theta and it's relationship to time. To visualize the scratches of a phonographer over a period of time, one must be able to track the movement of the sample in relation to the starting point(note: the starting point is equivalent to the **stylus** or **reference** point). Since a **scratch** is defined by the change in theta over time, scratching can be expressed through a modified version of the Cartesian graph. Thus scratches can be tabulated using theta as the y-axis and time as the x-axis.(see *fig A*)

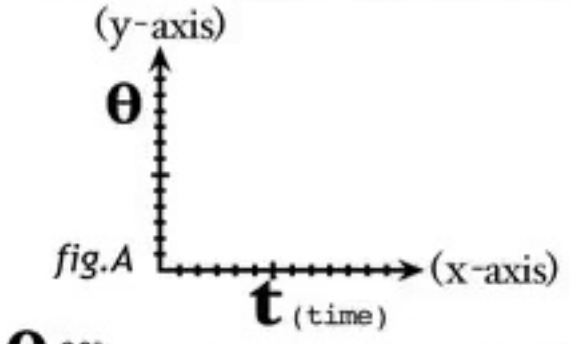


fig.A

Although the the relationship between theta and time can be tracked by the graph in *fig.A*, it can be more cleary expressed using the system of measurement displayed in *fig.B*. This structure is a modified version of the standard musical staff used in Western music today.

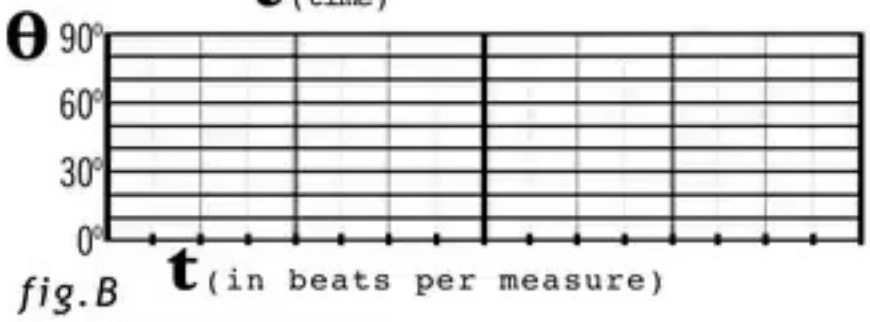


fig.B

The y-axis increments are called **degrees** which can therefore be represented by theta. This particular version of the staff's y-axis is called the **standard quadrant scale** because it represents one sector in a phonographer unit circle which is divided into fourths. Thus the y-axis(also known as theta) on this staff, represents *90°* divided into *10°* increments. Recall the fresh example on page 1. *Fig.C* shows the sample length of the fresh sound and, most importantly, its placement on the standard quadrant scale. The shaded sector of the phonographer unit circle represents the same number of degrees shaded in the staff. Later in this document, when we cover scales and pitches, we will delve into the other microtonal and Western systems of dividing the degrees.

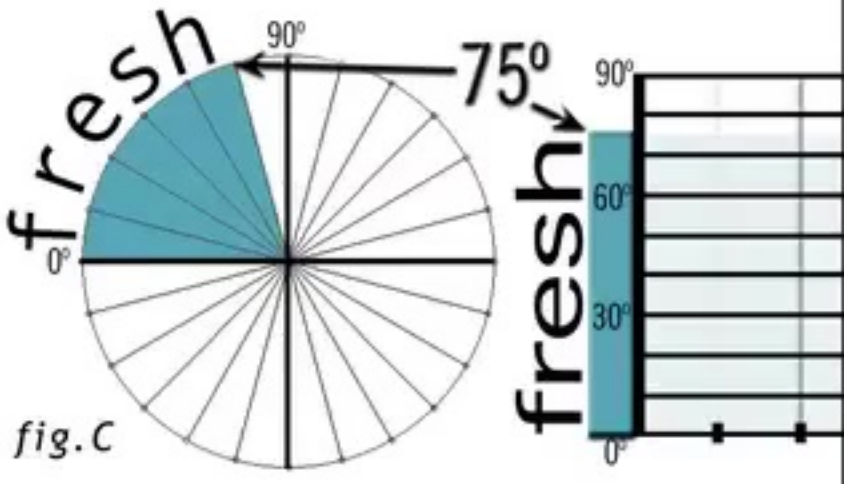


fig.C

The x-axis of the staff is a measure of time and can be divided into any number of increments depending on the **time signature**(located at the beginning of *Fig.D*). In this particular example, the time signature is 4/4 -meaning that there are four beats to every measure. In this picture, every four increments represents a single beat making the entire staff equal to one measure. The sixteenth note located at the upper left corner of the staff indicates the number of increments per measure- in this case sixteen notches. The 90° next to the theta character indicates the degree range of each sector and the 10° below it indicates the value of each increment within the sector. The numeral 1 located next to the sixteenth note indicates that the scratches are taking place within the first sector ranging from 0° to 90°. In sequential order, the numeral 2 would indicate the second sector ranging from 90° to 180° and so on.

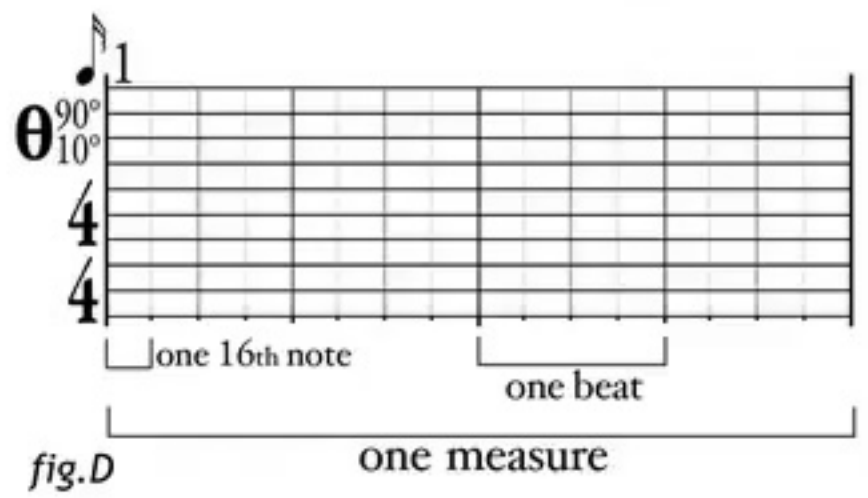


fig.D

So, what does this information mean to the phonographer?

By using theta over time, one can always track the movement of the record in relation to the beat. The examples displayed in *fig.E* present this system of measurement by assuming that the fresh sample just happens to be exactly one beat (this rarely happens in real life) and that the sample is moving on the platter at a constant speeds. Since physics tells us that velocity equals distance over time (v=d/t), we can infer that scratching equal degrees over time (S=d/t). By incorporating sheet music's beat based frame of time, we can change the equation to "degrees per beats" (S=d/b). In the first example in fig.E, the fresh sample has a speed of 75d/b meaning that the record is rotating 75° for every one beat. The second example shows the same sample rotating at a speed of 37.5d/b or 75° for every two beats. Example two is therefore moving at half the speed of example one. The phonetic interpretation displays this showing the effect of the sample being stretched to twice its normal length.Each example creates a line which is characterized by its **slope**, S, being equal to degrees over time. Thus the slope of examples one and two would be 75 and 37.5 because, once again, S=d/b. Take notice that the S which I used to define a scratch and the S which used to define the slope are the same thing.

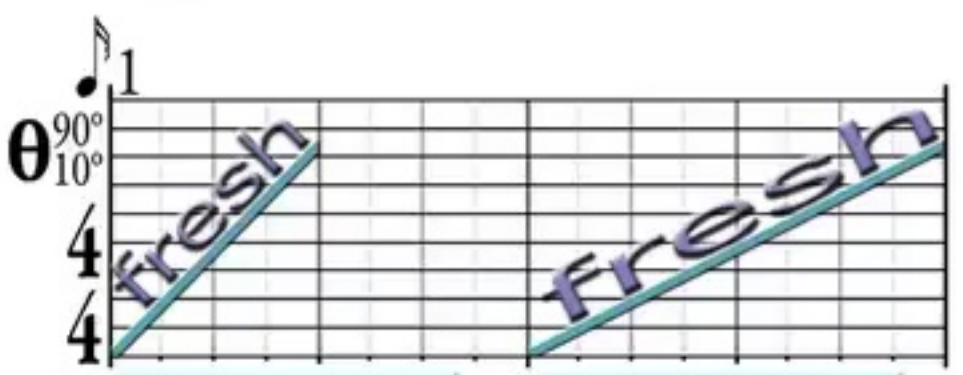


fig.E

phonetic interpretation: *fresh* *ffrreesshh*

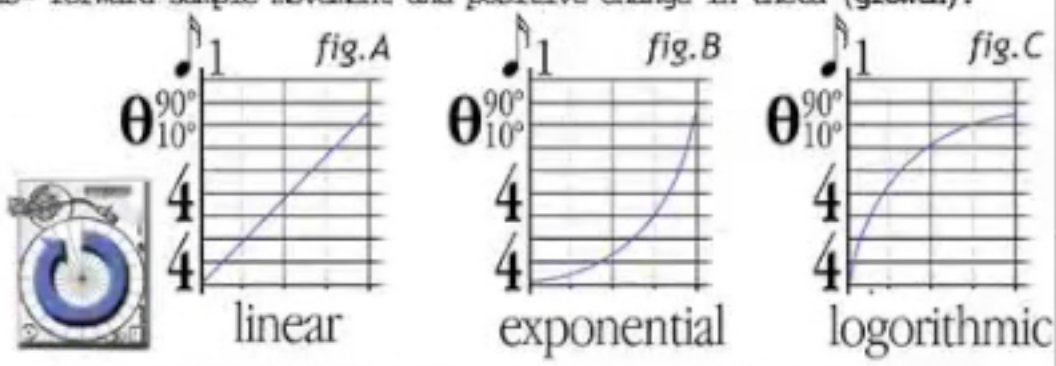
Velocity, Acceleration and the S-Curve

Scratching is changing the position of the record in relation to the position of the fader. Although there are an infinite number of ways in which one can alter a sample over a period of time, scratching can be categorized into three major types of movements. The first is **linear** movemet meaning that the change in theta over time produces a straight line on the phonographer staff (see *fig.A*). The fresh examples on page 2 dipict this form of rotation. The second type is **exponential** movement characterized by a curving line which dipicts a rapid change in the position of theta over a period of time (see *fig.B*). This type of curve starts out moving slowly and moves faster and faster as time passes- thus the record is speeding up. Through the use of physics, one can understand this exponetial movement as being equivalent to acceleration. In the same light, linear movement can expressed in terms of constant change or, as physisists call it, velocity. The third type of record movement is called **logorithmic** and is characterized by a rapid decrease in the change of theta over a period of time (see *fig.C*). This type of curve starts out moving fast and moves slower and slower as time passes- thus the record is slowing down. All three of these examples represent the forward/clockwise movement of the fresh sound along the record and can be discribed as a *push*. These type of movements reflect growth (or the positive change in theta). Conversely, figures D,E and F represent the backwards/counterclockwise movement of the record and can be discribed as a *pull*. These type of movements reflect decay (or the negative change in theta). All three of these motions, both forward and backward, are the elementary movements of all forms of cutting.

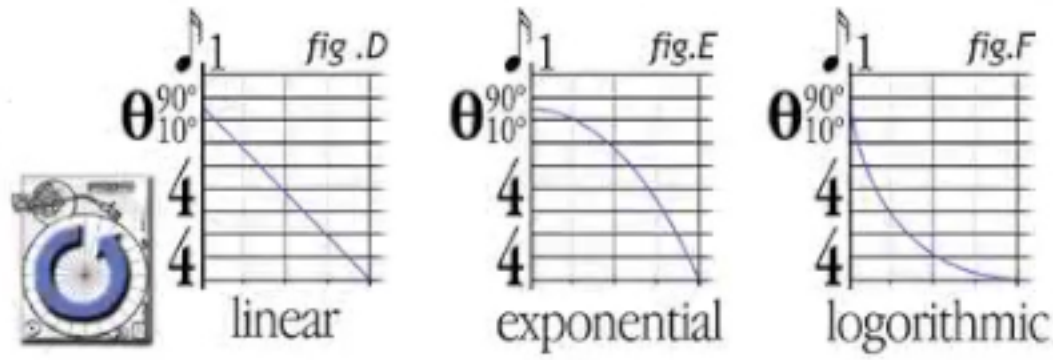
The slope of a scratch (the change in degrees over time) can never form a completely vertical line due to the fact that it would take an infinitely fast push or pull. Yet the slope of a scratch is able to form a horizontal line meaning that the record has a reached a speed of zero and continues to remain motionless.

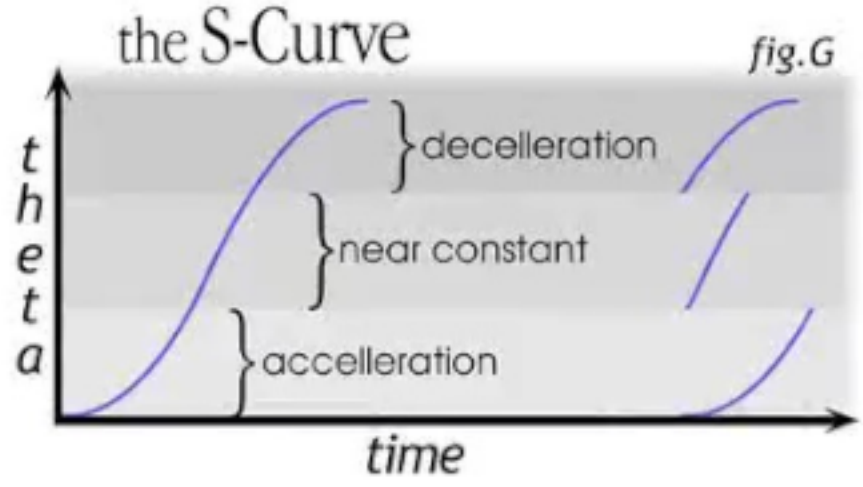
The most fundemental type of scratch is called a **Baby** scratch and can be represented by the **S-curve** on the phonographer staff. The S-curve is the union of all of the elementary movements culminating into a single smooth motion (see *fig.G*). This example is a push that initially accellerates from rest- then reaches a nearly constant speed- then deccelerates back to a speed of zero. The the 2nd region is called near-constant because it is not truly representative of linear movement. It is actually the end of the exponential growth followed by the beginning of logorithmic growth. Note that it is impossible to execute a perfectly linear movement with one's own hand. Only the turntable can move at exact speeds.

All of these examples dipict clockwise rotation which is the same as- *forward* sample movement and *positive* change in theta (**growth**).



All of the examples dipict counterclockwise rotation which is the same as- *backward* sample movement and *negative* change in theta (**decay**).





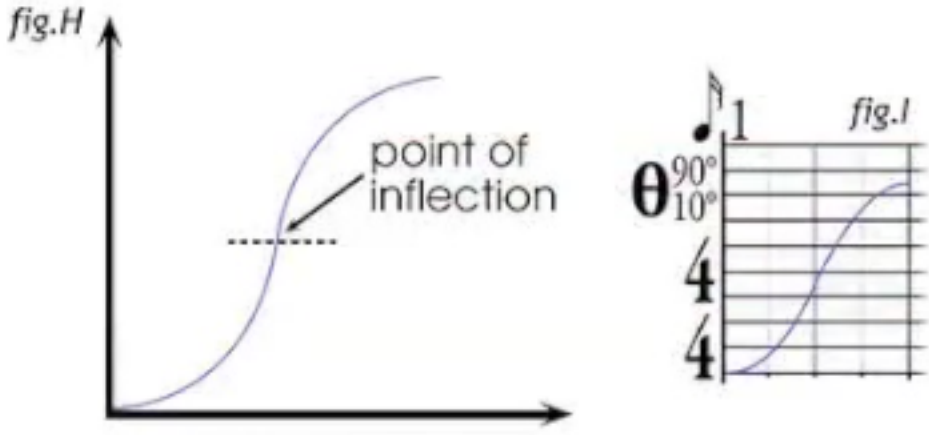


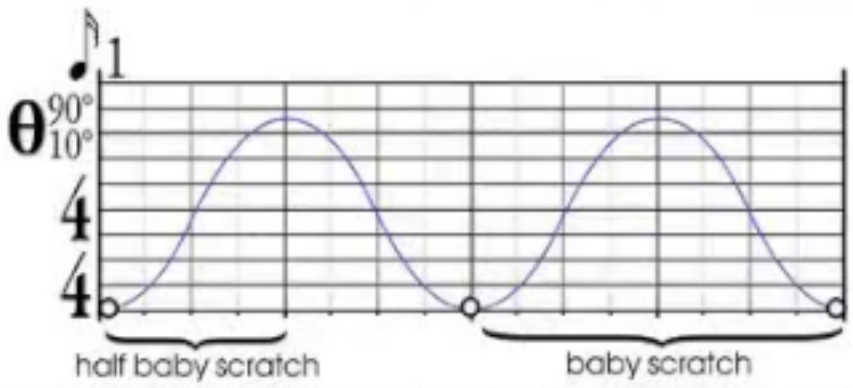
fig.H dipicts the point of inflection representing the transition from one elementary movement to another. *fig.I* dipicts a positive s-curve on a phonographer staff.

THE BABY SCRATCH AND THE FADER

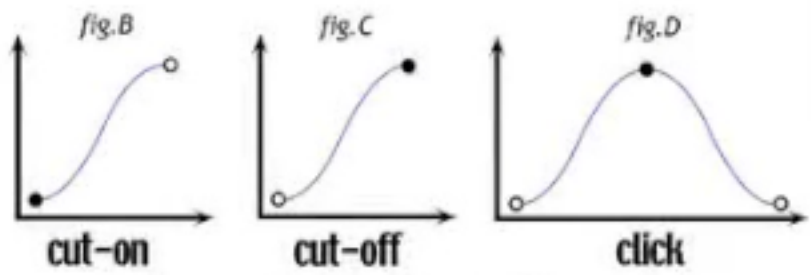
Most scratches are fundementally composed of Baby scratches and the gradual or immediate cut-off time of fader movements. Without the fader, the majority of scratches would be mere Baby scratches of various accents and lengths of time (though we do give names to many of these "click-free" variations). The fader therefore enables one to divide a sample into an infinity of sounds. It serves to manipulate the sample through the gradual to instantaneous cutting-off of sound- hence the **cut**.

Before a cut transpires, the phonographer must understand the open position dipicted in *fig.A* and the left column of the table in *Fig.E*. The symbol used to represent a fader in the open position is an open circle. Although this character could theoretically be placed at any number of points along the sample line, the phonographer is to use them sparingly. The first of the two major uses of the open symbol is dipicted at the beginning of the baby scratches in *fig.A*. This usage involves placing the symbol at the beginnings and ends of sample lines in order to clarify the status of the fader at the start or end of a measure. The second usage, as displayed in the very middle of the measure in fig.A, involves placing the symbols between scratches to separate scratches that have connected sample lines. Without the open symbol, the reading of more complicated scratches would be more difficult.

There are three basic types of fader movements that create a cut: the cutt-on, the cutt-off and the **click**. The cut-on and cut-off are self-explainatory, the former being the turning on of the sample and the latter being the turning off of the sample. Figures B and C depicts these phonographer symbols showing the cutting off and on of the sample line by a dot. These two cuts are one-swipe movements meaning that the fader turns either on or off in one swift motion. The third type of cut movement is called a click representing the turning off and on of the fader/switch. This cut is a two-swipe movement meaning that the fader is turned off and is immediately turned back on in one swift motion. Figure D dipicts this division of sound with a dot on the sample line. Thus the click is a momentary break in the sound emmitted from the mixer. Note that these cuts and their symbols are assumed to be relatively instantaneaous having no value in reference to the time signature(despite the fact that a real amount time expires while they're being executed). They are mere representations of the beginnings and ends of intervals of time. Gradual cuts, such as those involving the up and downs, balance, equalizers and all forms of effects generators, take a much longer time to change from the open to closed position thereby making their execution apt for notation over a period of time(p.5). As displayed in Fig.F, typical fader movements serve to selectively mute segments of a continuous flow of baby scratches.



The separation of these two baby scratches is based upon the assumption that a scratch constists of a movement with no more than one change of direction.

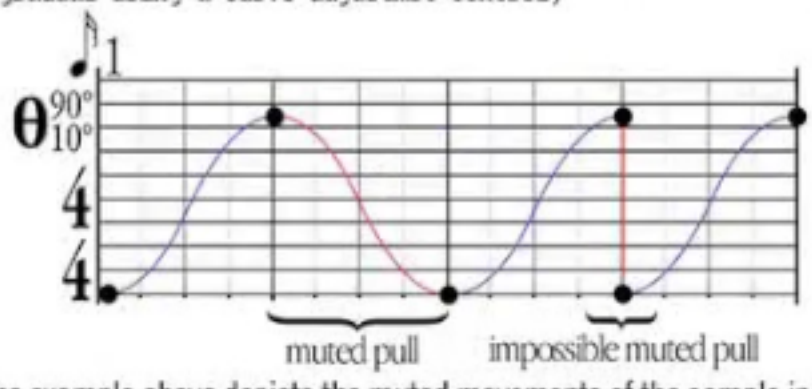


the above graphs dipict the use of the crossfader

fig.E

	Open position	Closed position
crossfader	○ on	● off
up and down*	○ on	◓ off
transformer	○ on	🌡 off
balance*	○ stereo	Ω fade left / fade right Ω
effects*	○ dry/off	⊗ wet

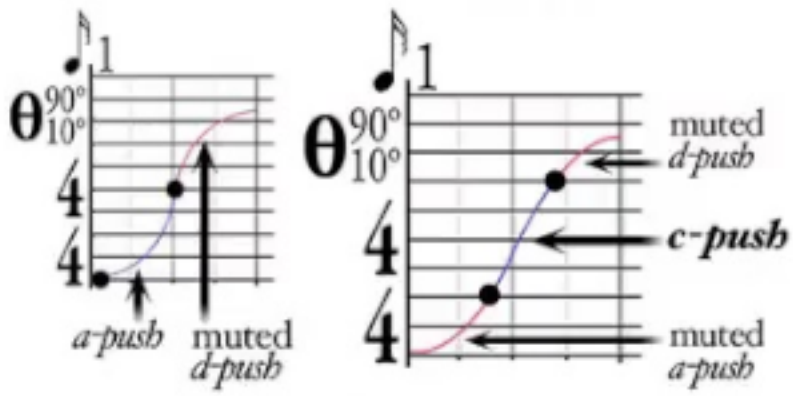
*denotes typically gradual faders- crossfaders and transformers are assumed to cut sharply(Note:the crossfader can be set to gradual using a curve adjustmet control)

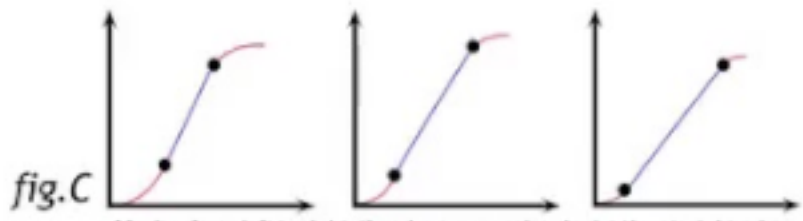


The example above depicts the muted movements of the sample in red. The first red line represents a muted pull which has a s-curve shape while the second one represents an impossible muted pull of infinite velocity- an instantaneous return to the start of the sample(this can only occur by layering the two scratches on a recording).

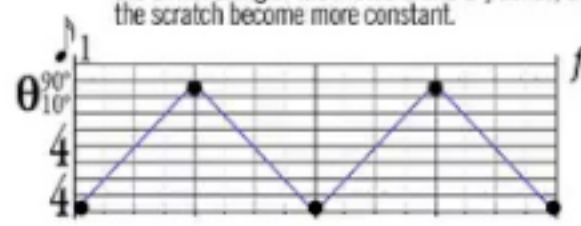
the sounds of the cut

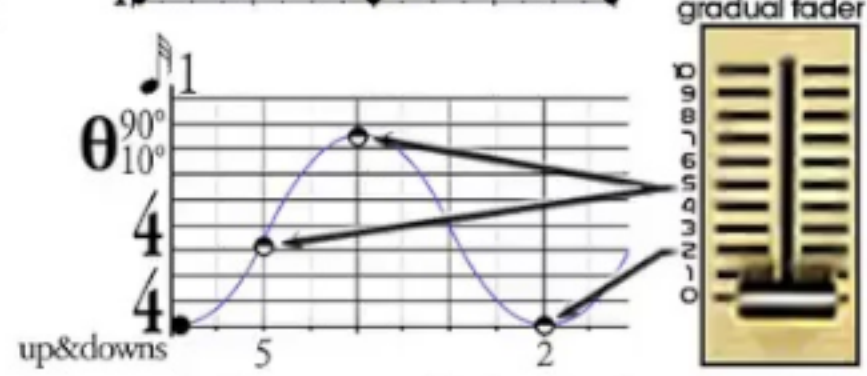
Cuts create different scratches by muting sections of the baby scratches- for every scratch has an underlying s-curve. Although the s-curve can be divided into an an infinite number of sample line segments,the division of this curve can be categorized using the elementatry scratches described on p.3. In order to hear an individual elementary scratch, one must mute the the rest of the s-curve on which it lies. *Fig.A* depicts this type of cut placement. This cut is an **a-push**(the "a" denotes acceleration) due to the fact that it's subsequent **d-push**(the "d" denotes deceleration) is being muted by the fader. Note that the cut is placed at the point where the a-push changes to a d-push, also known as the point of inflection. These two types of pushes have an ever-changing speed which thereby produces a sound with an ever-changing pitch. *Fig.B* depicts a **c-push**(the "c" denotes the near-constant or perfectly constant velocity). This push was created through the muting of the a-push that comes before it followed by the muting of the d-push that comes after it. Unless the constant velocity of turntable motor is being used, the c-push is the union of the near-constant tail of an a-push and the near-constant start of a d-push. The c-push has a constant speed which produces a contant pitch(also known as the slope.) Since it is impossible to push and pull without acceleration and deceleration, a c-push becomes more and more perfect as the a and d-push portion of the s-curve is decreased(see *fig.C*). Many scratches, such as a typical chirp, are based upon this logic- having a-pushes and pulls that are connected to each other through the virtual elimination of the a and d-pushes from the s-curve. (*see fig.D*). In this example, the sound of acceleration and decceleration seems to be absent due to the fact that they are rendered so small that the momentary click of the fader is able to mute it. This system holds true for all combinations of elementary pushes and pulls that follow each other.



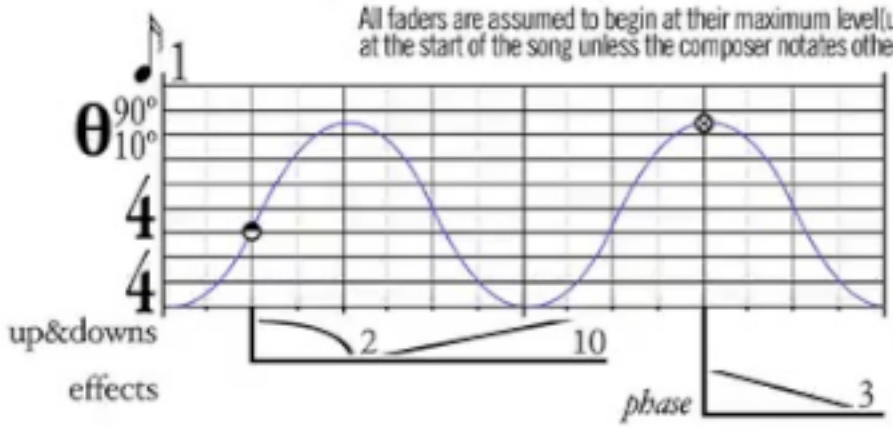


Moving from left to right, the above examples depict the straightening of the s-curved sample line. As the line becomes more straight, due to the diminishing of the muted a and d-pushes, the speed and pitch of the scratch become more constant.

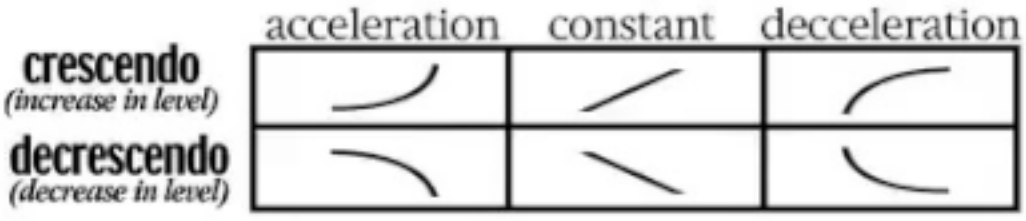




All faders are assumed to begin at their maximum level(usually 10) at the start of the song unless the composer notates otherwise.

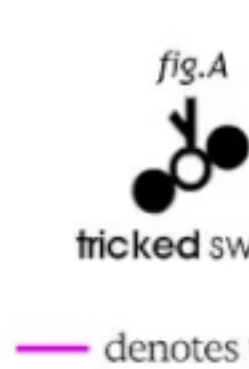


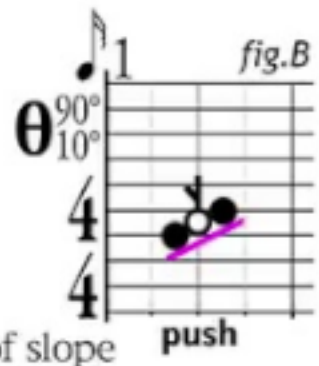
All of the different types of faders produce their own unique sounds due to their having different rates of cut-off as well the different types of effects which they produce. Although cuts have historically involved the changing of volume- the knobs, faders and switches of equilizers and effects units are all presently fair game making them deserving of their own notation. Thus crossfaders, transformers and the up and downs can be considered classical faders. Of these faders, the transformers and crossfaders have symbols that reflect their rapid cut-off rate; taking a mere point in time to click or cut. All other faders are categorized as **gradual**, having click and cut rates that take a significant amount of time to follow through. The levels and amount of time it takes to execute a fade is therefore in need of notation. Figures E and F depict these supplementary symbols. *Fig.E* displays the supplement to the click of a gradual fader which is to be placed directly unerneath the point in time which it occurs. The number represents the level at which the click reached along the gradual fader depicted in *fig.G*(note: unspecified click levels, as displayed in the second click in this example, are assumed to be the same as the last notated level).*Fig.F* displays the supplement to the cut-off and cut-on. The example shows the change in levels and all of the rates at which they are changed over time. These varying rates of **crescendo** and **decrescendo** are represented by symbols(shown in the table in *fig.H*) that correspond to the change in speed of fader within a gradual cut-ons and cut-offs.



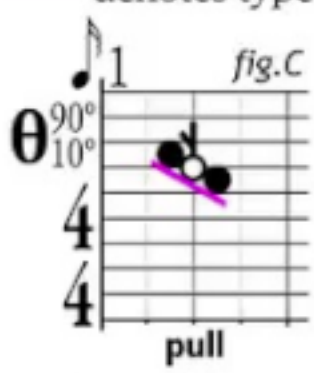
COMPLEX SOUNDS

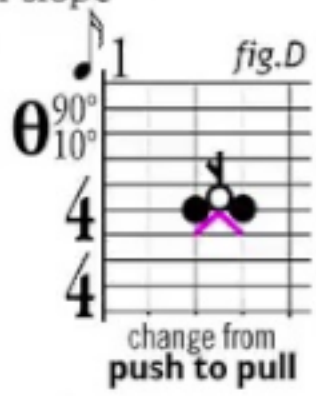
Within the realm of scratching, there are various types of fader and record movements that create stylized clicks and cuts that are alterior to those of the instant and gradual faders, switches and knobs previously discussed in this document. The **tricked** transformer switch is one of these instruments, creating it's own unique sound. The standard tricked switch is a tranformer that is able to go from off- to on- and back off in a single swipe. The symbol in *fig.A* is the notation for the tricked swipe. It represents this quick motion, and its according quick sound, as being the combination of the closed, open and closed movements of the transformer. *Figure B* depicts this symbol along the phonographer staff. It is of the utmost importance that one understands that the tricked swipe produces a single sound that only lasts as long as a click. This characteristc is vastly different from the majority of cuts which involve dividing as significantly longer interval of time. It is for this reason that there no visible wave along the staff in *fig.B*. If there were a visible wave, the cut would essentially become a transformer cut-on immediately followed by a cut-off. The only other source of information that the tricked swipe provides is the short slope of its three joined symbols(see *figs.B,C and D*). When swipes are repeated one after another, all three of these unified symbols are not needed due to the fact that each subsequent swipe will give a general "dotted" representation of the sample line(*see fig.E*). It is also important that the phonographer understand that the tricked swipe must always start in the closed transformer position and therefore must always have a tranformer cut-off preceeding it along the staff. (note:this preceeding transformer cut-off does not have to be tallyed on the staff if the sound is cut off by another fader- *fig.F* is an example of this).

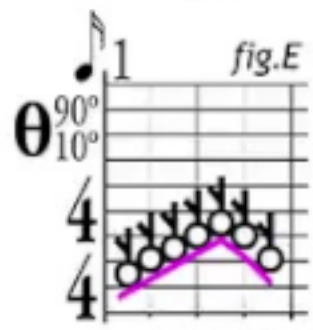


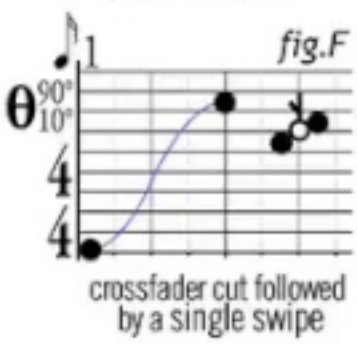


denotes type of slope

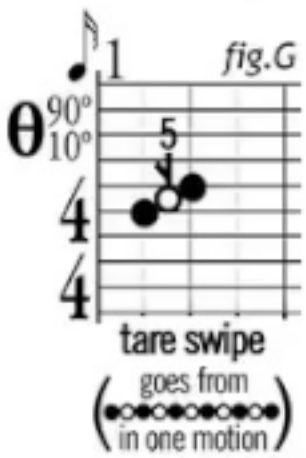


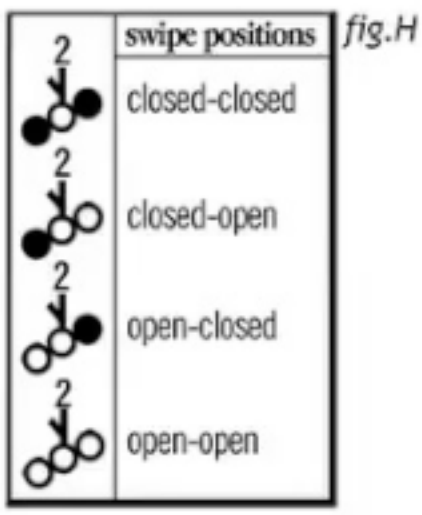




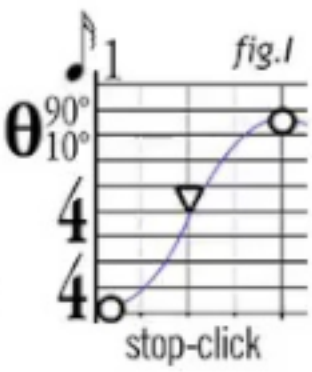


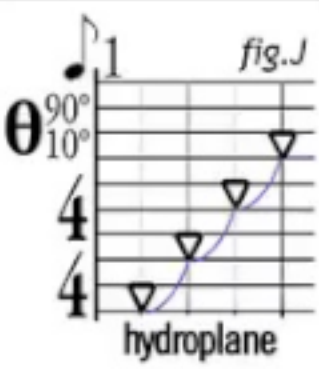
It is also possible to have tricked switiches that produce more than one sound per swipe. Although they haven't been invented yet...one could have a switch that turns off and on ten times in a single swipe. These future cutting devices, known as **supertricked** or **tare** switches, use the same symbols as standard tricked switches but the have a number above them which represents the number of times the sample is heard per swipe(see *fig.G*). If the number of sounds emmited in a swipe is long enough, the tare symbol must be accompanied by the rate at which the tearing occurs. This notation is to lie underneath the staff, as do all gradual rates of change, but must lack level indicators unless they are defined on the mixer. Since standard tricked switches begin and end with the transformer in the closed position, it is therefore possible to have a tare swipe that ends in the open position-or even one that starts and ends in the open position. These variants are to be notated accordingly as depicted in *Fig.H*.





Another click and cut sound which is different from typical faders is produced by what is known as a **stop**. A stop creates a click or a cut without the use of the fader by either tapping or holding the record. This is able to occur due to the fact that a record makes no sound when it stops. Thus a momentary stop of the record will produce a click- a hault will produce a cut-off and the movingof a stationary record will produce a cut-on. *Fig.I* displays the symbol for this "virtual cut" being a mere representation of the horizontal slope at which the sample line reaches when the record is stopped. These stops essential to many scratches, such as hydroplanes(displayed in Fig.J), as well as juggling.

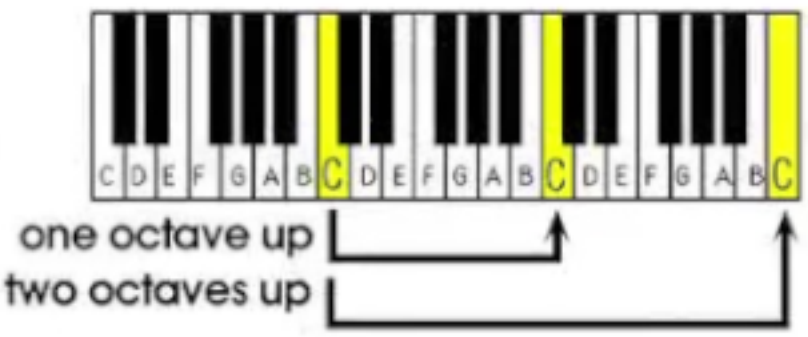


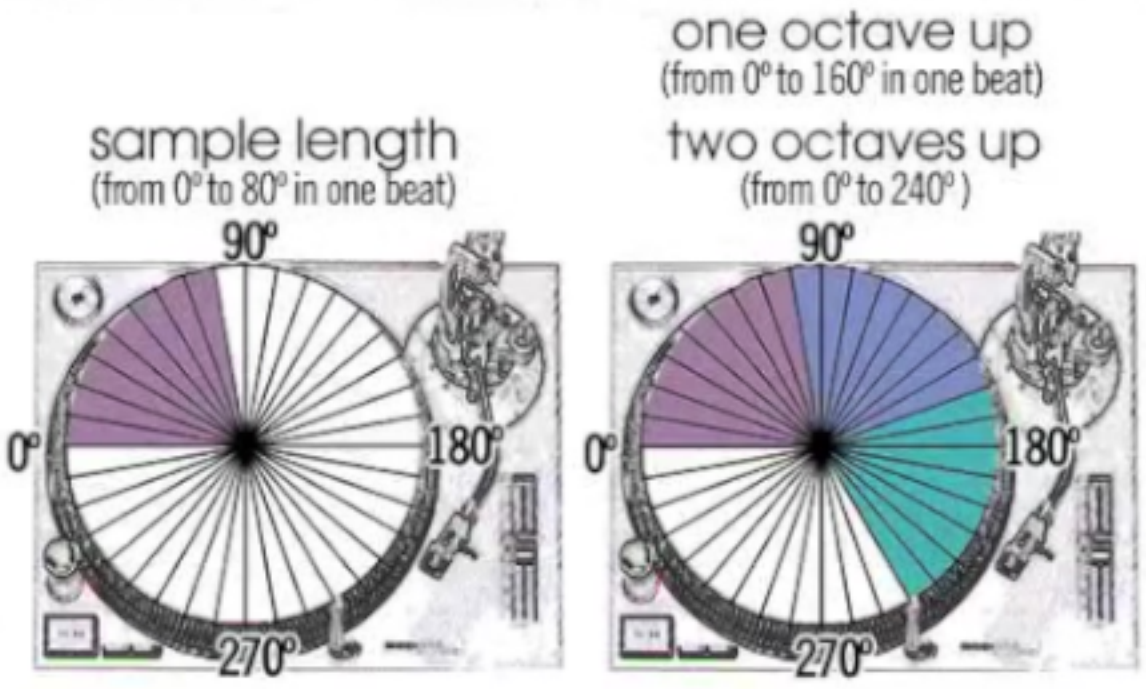


MICROTONAL AND STANDARD SCALES

Yes, a symphony of Turntablists can chirp and flare Beethoven's Fifth or even Louie Lou's Scratch Monopoly in D minor...

The first thing that a phonographer must understand is that velocity, speed and pitch are all one in the same. The pitch of a a record is therefore dependent on the distance it travels in a period of time (this can be expressed in degrees per second or beat) . The pitch will always increase and decrease along with speed as seen on the pitch adjust. One must also understand that for any constant speed at which a record is moving, twice that speed will produce a pitch that is one octave higher. This means that if a sample is c-pushed or pulled *n* degrees in a single beat, a c-push or pull of (*n* x 2) degrees in the same amount of time will be an octave up. Fig.A displays an octave on the piano, from C to the next C etc., while fig.B displays an octave on the turntable, from 0 to 80° and 0 to 160° etc. In this example, every extra 80° a sample travels in the same period of time is an octave up.





An octave can be as long as any number of degrees which the phonographer chooses. Depending on the type of musical scale being used, this octave can be divided into any number of notes. A **note** on the piano is defined by a sound that has its own unique wavelength - likewise, a note on the turntable is defined by a sound that has its own unique samplelength. Figure C shows this relationship using the standard western scales which is based on their being eight notes, which are divided into twelve half steps,per octave . In this example, an octave is equal to 120° and each step is equal to 10° . The phonographer scale has also been changed from the standard 90° sector to that of 120° . In this example, every half step is equal to 10° .